

Study Group 10

ELECTRONIC FUNDAMENTALS

Service Practices 19:

**HOW TO TROUBLESHOOT
A RADIO RECEIVER**

Service Practices 20:

SPECIAL TOOLS



RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

New York.

N. Y.

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 19

HOW TO TROUBLESHOOT A RADIO RECEIVER

19-1. Inoperative A-C Operated Receiver

19-2. Inoperative A.C.—D.C. Receiver



RCA INSTITUTES, INC.
A SERVICE OF RADIO CORPORATION OF AMERICA
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Service Practices 19

INTRODUCTION

For anyone who wants to become an expert electronics technician, there is no better way to begin than by learning to troubleshoot home-type radio receivers. Radio is the groundwork of electronics. Historically, the electronics industry grew out of the radio industry. The radio receiver is built upon simple versions of the circuits that make up modern electronics. Learn to service radios, and you will have little trouble learning to service other electronics devices.

Take the television receiver for example. It is similar to a radio receiver. Both receive and then reproduce programs from a broadcast station. The method of troubleshooting both receivers is much the same. However, with television, there is more to trouble-shoot — there is picture as well as sound.

The radio receiver has one purpose — to reproduce sound. When sound is completely absent from a radio receiver, it is an *inoperative*, or dead set. This lesson will deal with troubleshooting a dead set, using a minimum of test equipment. A multimeter and a tube tester will be needed. If a tube tester is not available, the tube-substitution technique described in Service Practices 10, *How to Test Tubes* will have to be used.

Let's consider two examples: an a-c operated radio-phonograph combination that we'll call Set A, and an a.c.—d.c. table-model radio that we'll call Set B

19-1. INOPERATIVE A-C OPERATED RECEIVER

Set A (Fig. 19-1) contains a radio chassis with a-c power supply and a record changer.

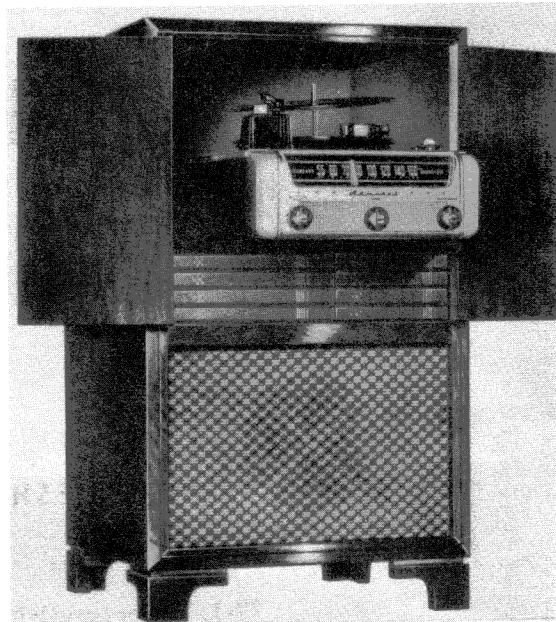


Fig. 19-1

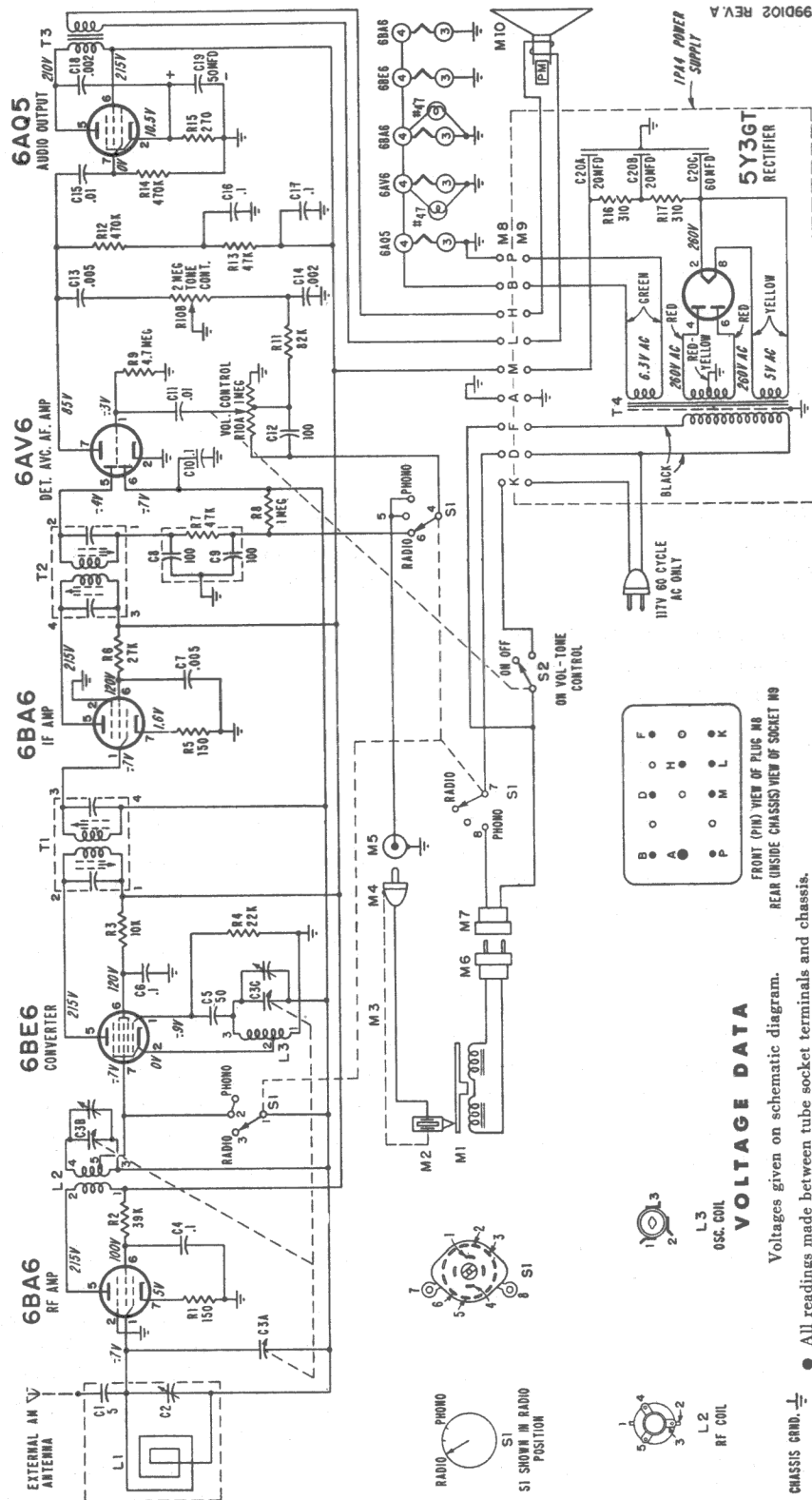
The schematic diagram (Fig. 19-2) shows that the set is made up of an r-f amplifier stage (6BA6), converter (6BE6), i-f amplifier stage (6BA6), audio detector, AVC, and audio voltage amplifier (6AV6), audio power output stage (6AQ5), and full-wave rectifier power supply (5Y3-GT). The schematic diagram in Fig. 19-2 will be referred to for troubleshooting Set A throughout this lesson.

The set is dead. The line cord is plugged in; the switch is on; the volume control is up; you have tried to tune a station, but this is a dead set. What should you do? Where should you start?

A System to Follow. One way to find the trouble is to test every part, every connection, and every connecting wire — one at a time. Of course, this would take too much time. Another way is to proceed aimlessly, testing things by chance. With luck, you might find the trouble on the first try but —

Admiral

**RADIO CHASSIS 5R2 and 1PA4 POWER SUPPLY
MODELS 6N25, 6N26, and 6N27**



- Radio-Phono switch in "Radio" position.
- Volume control minimum; dial turned to low end.
- Measured on 117 Volt, 60 Cycle AC line.
- Voltages measured with Vacuum Tube Voltmeter.

Fig. 19-2

more likely — you might not find it at all. A good system to follow is this:

1. Examine the trouble to decide *which section of the receiver is most likely to be at fault.*

2. Test the tube that goes with that section. If the tube is the trouble, you're finished.

3. If not, test all the rest of the tubes — just to be sure they are good.

4. If all tubes test good, examine the suspected section to decide what part or connection is at fault.

5. Continue to check parts and connections until you find the trouble or use up all the possibilities.

6. If you use up all the possibilities without finding the trouble, switch to the next most likely section and repeat Step 4.

You have a dead-set and you want to use the system. Step 1 tells you: *Examine the trouble (the trouble is absence of program sound) to decide which section ... is ... at fault.* It may seem impossible to examine *absence of program sound* and decide upon the faulty section, but it is not. For example:

1. You can listen for the hum. If you hear the hum, part of the receiver must be working. If there is no hum, *no* section of the receiver is working. This means power is not reaching the power transformer.

2. Turn on the record-player. If you can hear sound from the record, the part of the receiver that amplifies the record-sound must be working.

3. Listen for the hiss. If you hear the hiss, most of the receiver is working. However, the section that picks up broadcast signals is not working, since program sound is absent.

A list of trouble indicators, such as this list, can be continued without limit. Each

trouble indicator furnishes information needed to carry out steps of your troubleshooting system. Each step brings you closer to the trouble.

Testing Tubes. Start with the tubes. Tubes are the most frequent cause of trouble. It's easy to test tubes. You have no soldering to do, no need to take the chassis out of the cabinet. Test the suspected tube in a tube tester, or temporarily replace it with a good tube.

Start with a tube that *looks* bad — one that doesn't light, one that's dusty and old, etc. Glass tubes are used, so it's easy to see the glow of the heaters.

To find out if the heater is lighting in a metal tube, feel the jacket for heat after the set is on for a few minutes (long enough to warm up).

If none of the tubes light, power is not reaching the power transformer. Therefore, the next step is to check the power-supply primary circuit, which is the section that brings power to the transformer (*T₄*).

Checking the Power-Transformer Primary Circuit. There are a few quick checks to make before you thoroughly examine the power transformer primary section. Check the fuse (Set *A* does not have a fuse) by temporarily replacing it with a new one. Check the line cord by looking it over. If you are working in a customer's home, test the wall outlet for the presence of power. You can do this by plugging the receiver into another outlet, or by plugging a test lamp or meter into the suspected outlet.

For a thorough examination of the power primary circuit, use your ohmmeter and test for continuity (continuity is explained in Service Practices 17). A properly operating receiver with the switch turned on has continuity between the prongs of the power plug (Fig. 19-3). If the trouble is in the primary circuit, the set does not have continuity; to find the trouble you must find exactly where the primary circuit is opened. To do this, you test each separate part of the circuit for continuity. The parts are: the line cord,

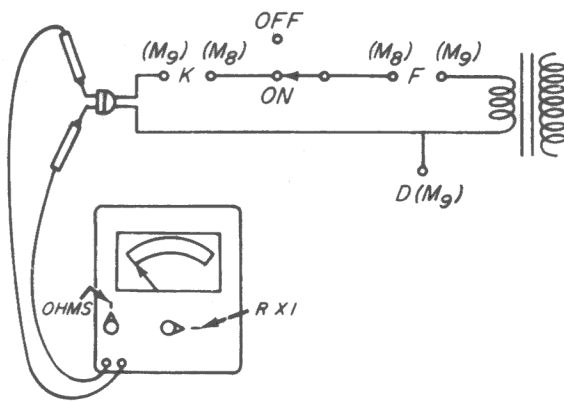


Fig. 19-3

the on-off switch, and the primary winding of the transformer.

You must remove the chassis from its cabinet to reach these parts. With Set A, it is necessary to remove only the power-supply chassis (1PA4 of Fig. 19-2), which is separate from the main chassis, and electrically coupled to it through a plug-in connector (M_8 and M_9 of Fig. 19-2 and 3). The connector must be plugged together while the primary circuit is being tested for continuity because the circuit is completed through connecting pins K and F, as shown in Fig. 19-3. Likewise, these pins should be separately tested for continuity during the examination of the primary circuit.

Checking the Power Secondary Circuit. If all the tubes light up, power is reaching the power transformer (T_4). Still, the trouble may be located in the power supply — in the circuit connected to the high-voltage secondary winding of the transformer. As a first step, test the 5Y3-GT rectifier tube — the tube that goes with the power-supply section of the receiver.

Caution: If the rectifier tube checks bad, do not replace it without first checking with an ohmmeter for a short circuit across C_{20C} (Fig. 19-2) — the input filter capacitor — because if C_{20C} is shorted, new tubes will blow out as fast as you put them in.

However, even if the tube checks good, you cannot be sure that the power supply is working right. In order to make sure, use the d-c voltmeter section of the multimeter to measure the $B+$ voltage from pin 2 of the 5Y3-GT to chassis. Your service notes tell you that this should be 260 volts.

If the voltage reading is higher than the normal 260-volt value, current is not flowing through filter resistors R_{16} and R_{17} (Fig. 19-2), and either one may be open. Shut off the set, and measure both resistors with an ohmmeter. The normal resistance value for each resistor is 310 ohms. Some receivers (other than Set A) use filter chokes instead of filter resistors. Chokes should be tested for continuity to make sure that the winding is not open.

If the voltage reading measured from pin 2 of the 5Y3-GT to chassis is much lower than the normal 260-volt value, turn the set off, and with your finger carefully touch R_{16} and R_{17} — withdrawing quickly to avoid a burn. If R_{17} is hot and R_{16} is cold, the 20- μ f filter capacitor (C_{20B}) is probably shorted. Check it with an ohmmeter. If both R_{16} and R_{17} are hot, either the 20- μ f electrolytic capacitor (C_{20A}), the 0.1- μ f bypass capacitor (C_{17}), the primary winding of T_1 , or the primary winding of T_2 is shorting to the chassis. To find out which is at fault: First, disconnect the power supply from the rest of the receiver by separating connectors M_8 and M_9 . (In radio receivers other than Set A, connectors are not used, and connections have to be opened by unsoldering the lead that connects to the $B+$ output of the power supply. Next, use your ohmmeter to measure the resistance between point A of R_{16} and chassis. If the resistance reading is low, C_{20A} must be shorted since C_{17} , and T_1 , and T_2 are disconnected. If the meter indicates the normal leakage resistance of electrolytic capacitor C_{20A} , it is not shorted. C_{17} may be shorted. Disconnect one lead of capacitor C_{17} from the circuit, and measure resistance across its terminals. If C_{17} is not shorted, the trouble may be in either T_1 or T_2 . Reconnect C_{17} . Disconnect the primary lead of T_1 (Fig. 19-4a) and measure resistance between the disconnected lead and chassis. If the ohmmeter shows a zero-ohms or low-ohms indication, this means that the primary winding is shorted to chassis; a bared lead or connecting lug inside the shield can of T_1 is probably touching the can which, in turn, is connected to the chassis. Check T_2 in the same way (Fig. 19-4b).

If there is no d-c voltage reading between pin 2 of the 5Y3-GT and the chassis (the

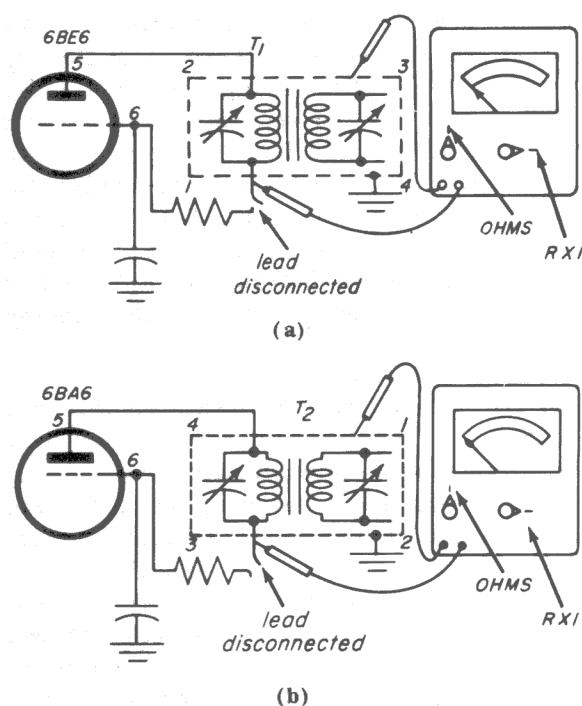


Fig. 19-4

meter indicates zero volts), check the a-c voltage at the power transformer secondary winding. Use the 1,500 volts a-c meter scale at first, to avoid driving the pointer off scale. Measure the secondary voltage between pin 4 and pin 6 of the 5Y3. The normal reading is 260 volts. If no a-c voltage is measured between pins 4 and 6, the power transformer (T_4) is defective and must be replaced. (You know that a-c input voltage exists at the transformer primary, because all the tubes are lighting).

How To Check for Live Audio. If you find that there is trouble in the audio section of the receiver, there are two ways to quickly check the entire audio section to see if it is alive and able to amplify an audio signal:

1. With Set A, you can turn the phonoradio selector switch to the phono position and play a record. If you can hear sound from the phonograph, the audio section is all right; the trouble is in the r-f section, the detector, or possibly the power supply.

2. With a dead set that does not have a phonograph, you can advance the volume control knob to the loudest position (full clockwise), and touch a finger to the center lug (movable arm) of the volume control — a

loud hum, heard in the speaker, tells you that the audio section of the set is all right. Set A also can be checked this way. If no sound is heard in the speaker when one of the live-audio checks is made, probably the trouble is in the audio section. However, it may also be in the power supply section — check B+. Make sure that the 6AV6 and 6AQ5 audio tubes and the 5Y3 rectifier tube are not defective. If the tubes are found to be good, the audio section should be checked further.

Checking the Audio Power-Output Stage.

The audio output stage (Fig. 19-2) consists of the circuit between the control grid of the 6AQ5 tube (pin 7) and the loudspeaker voice coil. To find out if this stage is alive, turn the set on and touch the metal blade of a screwdriver to pin 7, allowing your fingers to touch the screwdriver shank. A click should be heard from the speaker. If no click is heard, this means that the stage is dead; proceed as follows:

Check the screen-grid voltage. The d-c voltage normally delivered by the power supply to the screen grid (pin 6) is 215 volts, assuming that the power supply is operating normally. Check the plate (pin 5) voltage. This should be about five volts less than the screen-grid voltage or 210 volts d.c. The 5-volt drop is due to plate current flow that causes five volts to develop across the resistance of the primary winding of T_3 .

If the plate voltage is zero (with normal screen grid voltage), the primary of output transformer T_3 is open. A short across the T_3 primary places the 6AQ5 plate and screen grid at the same d-c potential (no 5-volt difference), and the audio signal is shorted out.

In other receivers than Set A, C_{18} (Fig. 19-2) may be connected as shown in Fig. 19-5. It is connected from plate to screen grid (Fig. 19-5), instead of from plate to cathode (Fig. 19-2). Both methods of connecting C_{18} place it in the same electrical position for the signal; not so for B+. Where C_{18} is connected from plate to screen grid, it can cause a short across the primary of the output transformer and place the 6AQ5

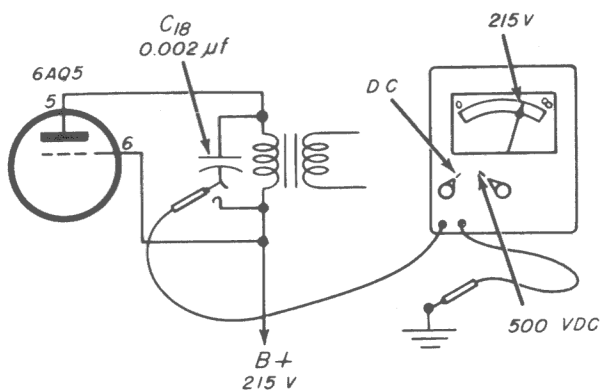


Fig. 19-5

plate and screen grid at the same d-c potential. Where it is connected as for Set A (Fig. 19-2), it can cause a short from the plate of the 6AQ5 to chassis through the low resistance of the cathode resistor (R_{15}). In either case, to find out if C_{18} is shorted, disconnect it (from cathode pin 2 or screen grid pin 6), leaving the plate (pin 5) connected. With the set turned on, touch the voltmeter probe to the disconnected lead of C_{18} . If the voltmeter indicates B+ (approximately 215 volts in Set A), this means that the capacitor is shorted; you cannot read d-c voltage through a capacitor unless it is shorted.

Another trouble that can cause plate and screen voltage readings to be equal (no 5-volt difference) is absence of electron flow through the 6AQ5 tube. This can be due to an open circuit between the cathode and B- (Fig. 19-6). As you see, R_{15} connects the cathode to chassis (B-). To check R_{15} , shut the set off and connect the ohmmeter leads from pin 2 of the 6AQ5 to chassis. The resistance reading should be 270 ohms. A very high resistance reading indi-

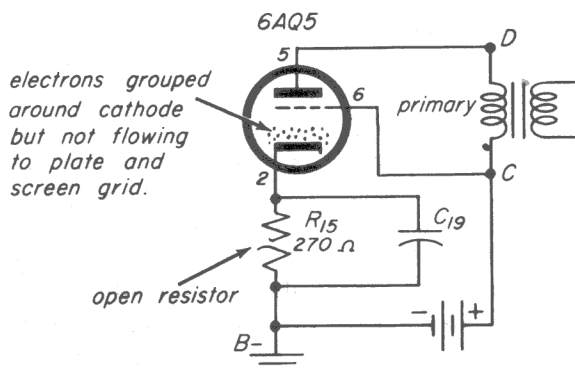


Fig. 19-6

cates that R_{15} is open; your meter shows the leakage resistance of the 50-μf electrolytic capacitor C_{19} ; R_{15} should be replaced. With this trouble, the voltage reading at the cathode (pin 2) of the 6AQ5, is approximately B+ (200 volts). C_{19} charges to B+. However, even with C_{19} disconnected, the voltage reading is B+. The reason is that your meter—placed between the cathode of the 6AQ5 and chassis—closes the open circuit and allows current to flow through the tube. But the resistance of the meter is many times larger than the cathode-to-plate resistance of the tube. Hence, most of the voltage (B+) that is applied to the tube plate divides across the resistance of the meter, where it causes a reading—not across the tube, where it would subtract from the reading.

If all the voltage readings of the 6AQ5 tube are normal, check the loudspeaker circuit (Fig. 19-2 and 19-7). Separate connectors M_8 and M_9 ; connect the ohmmeter leads across the speaker voice-coil terminals (L and H of connector M_9); switch the meter to the R x 1 scale. The resistance of a normal voice coil is low (about 3 or 4 ohms). The speaker clicks at the instant that an ohmmeter is connected across a normal voice coil. An infinite reading and no click sound indicates that the voice-coil winding is open. Next, check the secondary winding of transformer T_3 with the ohmmeter still set to the R x 1 scale. Place the meter leads across terminals L and H of connector M_8 (Fig. 19-7). A very low resistance reading

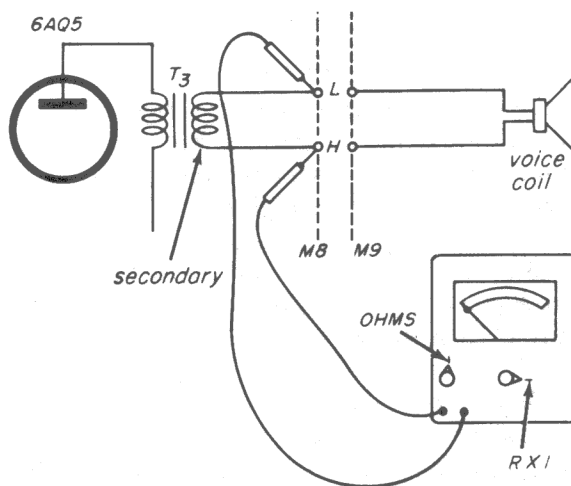
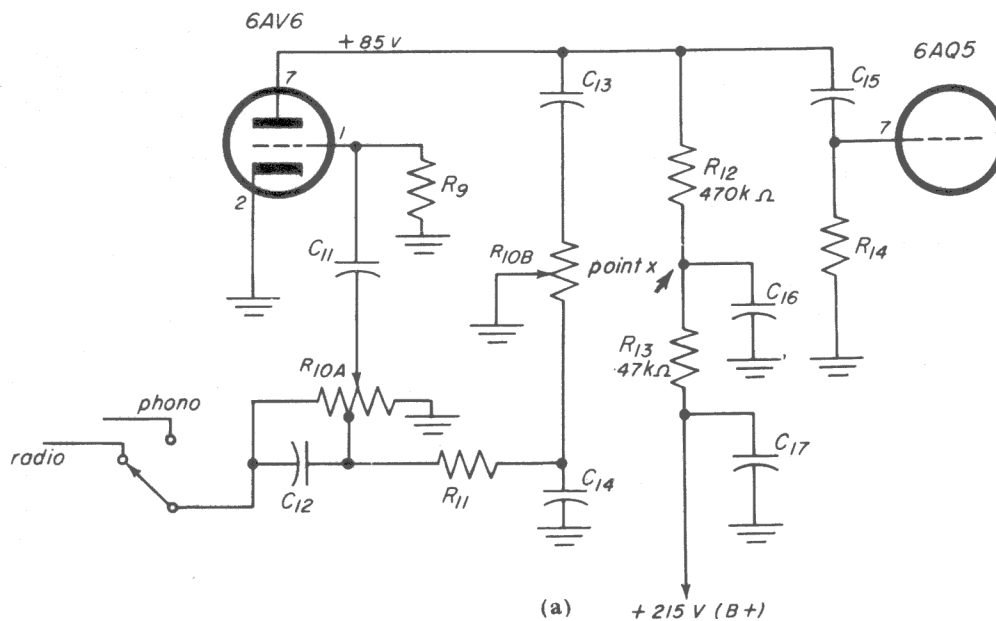


Fig. 19-7



former (T_3 in Set A) to the voice coil. Then separately check the voice coil and the transformer winding in the manner described above.

Checking the 6AV6 Audio Stage. The 6AV6 stage (Fig. 19-2) begins at the control grid of the 6AV6 (pin 1) and ends at the control grid of the 6AQ5 (pin 7). The circuit for only this stage is shown in Fig. 19-8a.

You should read about 85 volts at the plate (pin 7) of the 6AV6. If the voltage reading is zero, shut the set off and read the resistance of R_{12} . R_{12} should be 470 k-ohms. If the resistance of R_{12} is normal (but the plate-voltage is zero), connect the voltmeter leads between point X (Fig. 19-8a) and the chassis and turn the set on. If you get a zero voltage reading, C_{16} —the 0.1- μ f bypass capacitor—is probably shorted. However, if both R_{12} and C_{16} check all right, R_{13} may be opened; check its resistance.

Suppose R_{12} , C_{16} , and R_{13} all check all right, and the voltage at X is normal. Still, the plate-voltage reading is zero. C_{13} may be shorting the plate of the 6AV6 to B— (the chassis) through the tone control (R_{10B} , Fig. 19-8b). To find out, turn the tone control knob to its full treble position. Again check the voltage at the plate (pin 7) of the 6AV6. If a voltage reading (somewhat less than the normal 85 volts) is

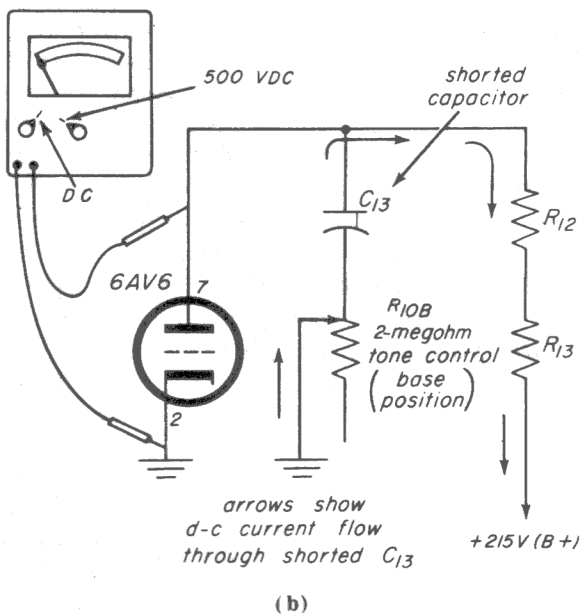


Fig. 19-8

(almost zero ohms) indicates that the winding is all right. An infinite reading indicates that the winding is open; the output transformer T_3 should be replaced. If the speaker and secondary windings both check normal, make sure that connector contacts L and H of M_8 and M_9 are tight and make good electrical connection.

When you test the voice-coil and output-transformer secondary windings of radio receivers that do not have connector plugs like M_8 and M_9 , disconnect one of the leads connecting the secondary of the output trans-

now obtained, C_{13} is probably shorted; check it with your ohmmeter. The excessive direct current flow through R_{10B} (the tone control) may have damaged the control. It may make noise when it is adjusted; if so, replace it.

Another trouble that can cause low plate voltage with normal voltage at X is a short across coupling capacitor C_{15} . Disconnect one lead of C_{15} from the circuit and test the capacitor for resistance with an ohmmeter, or try to read B+ through it with a voltmeter.

Suppose that the plate voltage for the 6AV6 is correct (85 volts) but the 6AV6 stage is dead. In this case, you look for troubles that can cause complete loss of the audio signal without causing the 6AV6 plate voltage to change—troubles that open or short the signal circuit without opening or shorting the B+ circuit.

Opened coupling capacitors (C_{15} and C_{11} , Fig. 19-8a) can cause this. A fast way to check a capacitor for an open circuit (not for a short circuit) is to temporarily connect a good capacitor in parallel with it. If doing so corrects the receiver's trouble, the suspected capacitor is opened. Take C_{15} for example. Connect another 0.01- μf capacitor in parallel with C_{15} (Fig. 19-9a). Turn the receiver on and either tune in a station or play a phonograph record. If the receiver operates, remove the temporary capacitor and replace C_{15} with a new capacitor.

Another trouble that can cause the 6AV6 stage to be dead without causing low plate voltage is a short to ground in the control-grid circuit. The grid may be grounded through the volume control (R_{10A} of Fig. 19-9b). Volume-control lugs are usually located close to the chassis; make sure that normally ungrounded lugs are not touching the chassis. For example, a lump of solder can ground these lugs (Fig. 19-9b). To check lug number 2 of R_{10A} for a short to ground, set the control to the most clockwise (loudest) position so that lug number 2 (the moving arm) contacts lug number 3 inside of the control. At this setting, the resistance to ground (lug 1) from lug number 2 should be 1 megohm—the resistance of the control. If the resistance is zero ohms, there is a short to ground at lug 2.

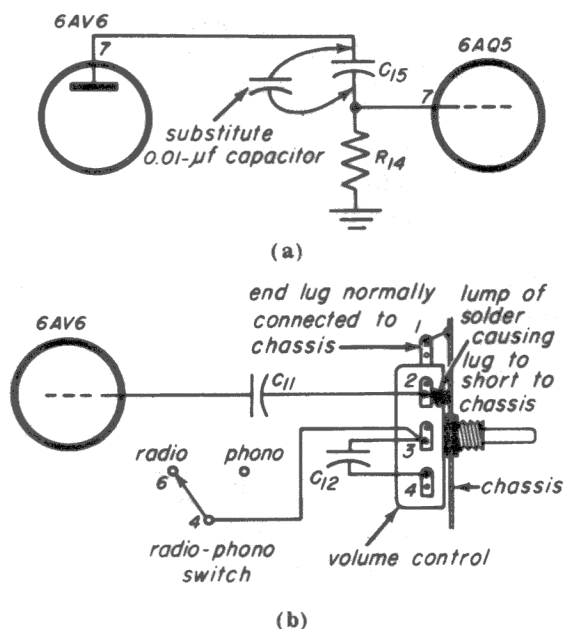


Fig. 19-9

Checking the Detector-Diode Plate Circuit.

There is a continuous electric path between the diode plate and the volume control (Fig. 19-10). Turn the volume control maximum clockwise. Touching the diode plate with your finger-held screwdriver is the same as touching the volume control. When you touch the plate, you should hear a hum or buzz from the speaker—just as you hear a hum when you touch the volume control. If you do not hear the hum when you touch the diode plate, this means that the continuous path to the volume control is broken.

Check with your ohmmeter to find out where it is broken (Fig. 19-10). The normal resistance from pin 5 of the 6AV6 to ground is the sum of the resistance of T_2 (between

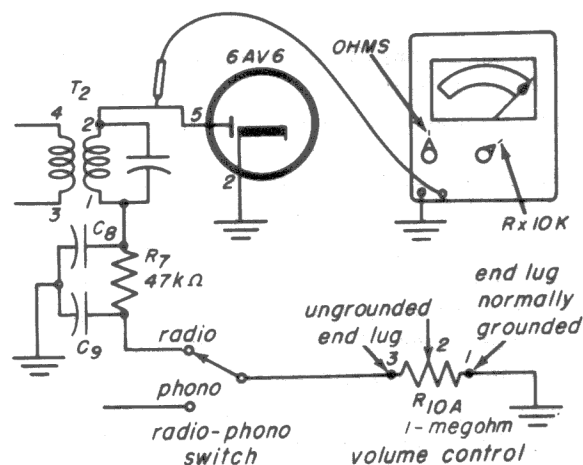


Fig. 19-10

terminals 1 and 2), the resistance of R_7 and the resistance of R_{10A} (the volume control). The total resistance is about 1,047,000 ohms. If your ohmmeter indicates a much lower resistance, there is a short in the diode circuit. If it indicates an infinite resistance, there is an open in the diode circuit.

Suppose your meter indicates infinite resistance from pin 5 of the 6AV6 to ground; you know that there is a break in the electric path. Here is the way to locate the break:

1. Actually, the break is at the phono-radio switch; the switch is set at the phono position. However, you do not know this; you are going to locate the break.

2. You move the meter probe from pin 5 (Fig. 19-10) to terminal 1 of T_2 . Still, the meter shows infinite resistance. You move the probe to the *radio* terminal of the switch; the resistance is infinite. You move it to terminal 3 of the volume control; the resistance here is 1,000,000 ohms. So, the break must be between terminal 3 of the control and the *radio* terminal of the switch. To double check, you return the probe to the *radio* terminal—infinite resistance, again. You throw the switch. The meter pointer moves to the 1,000,000 ohm mark. You have found the trouble.

Caution: To avoid unnecessary troubleshooting, carefully set all switches to the correct position before you begin.

Suppose your meter indicates a few ohms resistance from pin 5 to ground. Here is the way to locate the short:

1. Actually, the short is at terminal 1 of T_2 ; but you do not know this.

2. You move the probe from pin 5 (Fig. 19-10) to terminal 1 of T_2 . The meter pointer indicates zero. You move the probe to the *radio* terminal of the switch. The meter indicates 47,000 ohms, the resistance of R_7 . Now, you know the short is at terminal 1 of T_2 . The short must be at the point of lowest resistance.

Checking the I-F Amplifier. With the set turned on, and the volume control advanced, a loud click is heard in the speaker when you touch a screwdriver blade to the control grid (pin 1) of the 6BA6 i-f amplifier tube if the i-f, detector, and audio stages are working. However, assume that no click is heard, indicating that the i-f stage is dead and must be checked. (You have already checked the detector and audio stages.)

After testing the 6BA6 tube, measure the d-c plate voltage of the 6BA6. Connect the voltmeter leads between pin 5 and chassis. The voltage reading is normally 215 volts (Fig. 19-2). If the voltage reading is zero the primary winding of T_2 is open. (Assume that the power supply is delivering 215 volts, to terminal 3 of T_2 .) It can be said that the terminals of T_2 are not shorted to chassis. If they were, zero voltage would result at the screen grid of the 6AQ5, causing the audio stages to be dead. If the voltage at the 6BA6 plate is correct, check the screen-grid voltage. The normal voltage measured from the screen grid (pin 6) to chassis is 120 volts. If this voltage is zero and R_6 is hot, capacitor C_7 is shorted. If resistor R_6 is cold, it may be open. If the screen-grid voltage is too high (measures 215 volts), current is not flowing through R_6 ; there is no voltage drop across R_6 . Since this current flows through the tube, the 150-ohm cathode resistor may be open, or too high in resistance—thus preventing current flow through the tube and R_6 .

If all voltages check normal in the i-f amplifier stage (but the stage is dead), check the resistance of the primary winding of T_2 (from terminal 3 to terminal 4). If the meter indicates zero ohms, the capacitor across the primary winding is shorted. The normal primary winding resistance is only a few ohms. Check the resistance of the secondary winding of T_2 to make sure that the capacitor across it is not shorted. This defect does not show up as the screwdriver test is made at the detector diode plate because the path from the detector plate to the volume control is not opened. Make a resistance check for a short across the secondary terminals (3 and 4) of the i-f transformer (T_1).

Checking the Converter Circuit. With the set turned on, in the radio position, make a click test; touch the screwdriver blade to pin 7, the signal grid of the 6BE6 tube. If a click is not heard the stage is dead. (You have already tested, the i-f, detector, and audio stages.) Test the 6BE6 tube in a tube checker or substitute a new one.

Troubleshooting the converter is much like troubleshooting the i-f stage. The plate voltage from pin 5 to chassis should be 215 volts. If a zero-voltage reading is obtained, the primary of T_1 is open. The primary of T_1 is not shorted to chassis; otherwise, zero voltage would exist at pin 6 of the 6AQ5, and the audio stage would be dead. If the plate voltage of the 6BE6 tube is normal, check the screen grid voltage at pin 6. If the voltage reads zero and R_3 is hot, C_6 is probably shorted; but if R_3 is cold, R_3 is probably open. If the screen-grid voltage reading is too high, the lower portion of inductor L_3 is open between terminal 2 and the chassis, resulting in no electron flow from the cathode through R_3 .

If everything checks all right up to this point, and the converter stage is dead, check the resistance between terminals 3 and 4 of the secondary winding of the r-f coil L_2 . If your meter shows zero ohms instead of the small d-c resistance of the coil, the trimmer capacitor C_3B (Fig. 19-2) may be shorted; examine the mica insulation between the trimmer plates for any defects.

Checking the Oscillator Circuit. Assume that a click response is obtained at the signal grid of the 6BE6 converter tube. Then, the trouble is either in the r-f amplifier stage (6BA6) or the oscillator portion of the converter stage. To find out which is at fault, connect a 10-foot length of wire to pin 7 of the 6BE6 converter stage. Try tuning in a station. If some stations can be tuned in, the oscillator circuit is all right and the trouble lies in the r-f amplifier stage. This test does not work in a poor reception location; the oscillator may still be all right. To check the oscillator (to find out if it is oscillating), measure the grid voltage (pin 1 of the 6BE6). Connect the d-c voltmeter as shown in Fig. 19-11. Place a 100 k-ohm

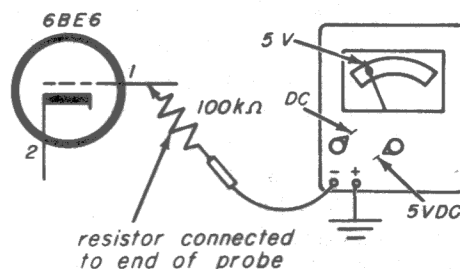


Fig. 19-11

resistor in series with the end of the voltmeter probe. A negative voltage reading of about 5 volts, or higher, should be obtained.

If a zero-voltage indication is obtained, make a resistance check from pin 1 to chassis. The normal resistance reading is 22 k-ohms (R_4). An infinite reading indicates that R_4 is open. A very low or almost zero ohms reading from pin 1 to chassis indicates that the grid capacitor C_5 is shorted. Continue by checking the resistance of the oscillator coil (L_3) between terminals 2 and 3.

You check R_4 for an open circuit, C_5 for a short. Why not check R_4 for a short and C_5 (a mica capacitor) for an open? Resistors usually fail by going up and up in value over a period of time. Finally, they open. Mica capacitors, such as C_5 , usually fail by shorting. They usually do not open. Paper capacitors both short and open. A shorted capacitor can cause too much current to flow through a resistor connected to it. The resistor overheats, and its structure breaks down. You may measure a low resistance—a short—across a resistor that has been damaged by a shorted capacitor. Such a resistor should be replaced, after the shorted capacitor has been located and replaced. These general rules apply to all circuits in which resistors and capacitors are found, not only to the oscillator circuit of Set A.

If everything in the oscillator circuit checks normal, but the circuit still does not work, disconnect capacitor C_5 from the circuit and substitute another 50- μf capacitor in its place. Do not test C_5 by placing another 50- μf capacitor in parallel with it. This tests for an open capacitor, and mica capacitors, like C_5 , usually do not open. Temporarily replacing C_5 tests it for a short and, at the same time, tests for all other possible defects (open, wrong value, etc.).

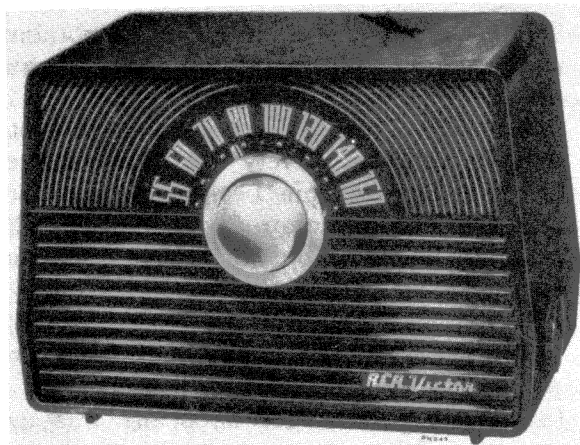
Checking the R-F Amplifier Circuit. Assume that the oscillator circuit is operating properly. Either a radio station can be tuned in when a 10-foot lead is connected to pin 7 of the 6BE6 tube (When the 10-foot lead is removed, the set is dead), or else a negative bias voltage can be measured between pin 1 and the chassis. This places the cause of the trouble in the r-f amplifier circuit.

Make a screwdriver click test at pin 1 of the 6AB6 r-f amplifier tube. If a click is heard but signals cannot be received, the

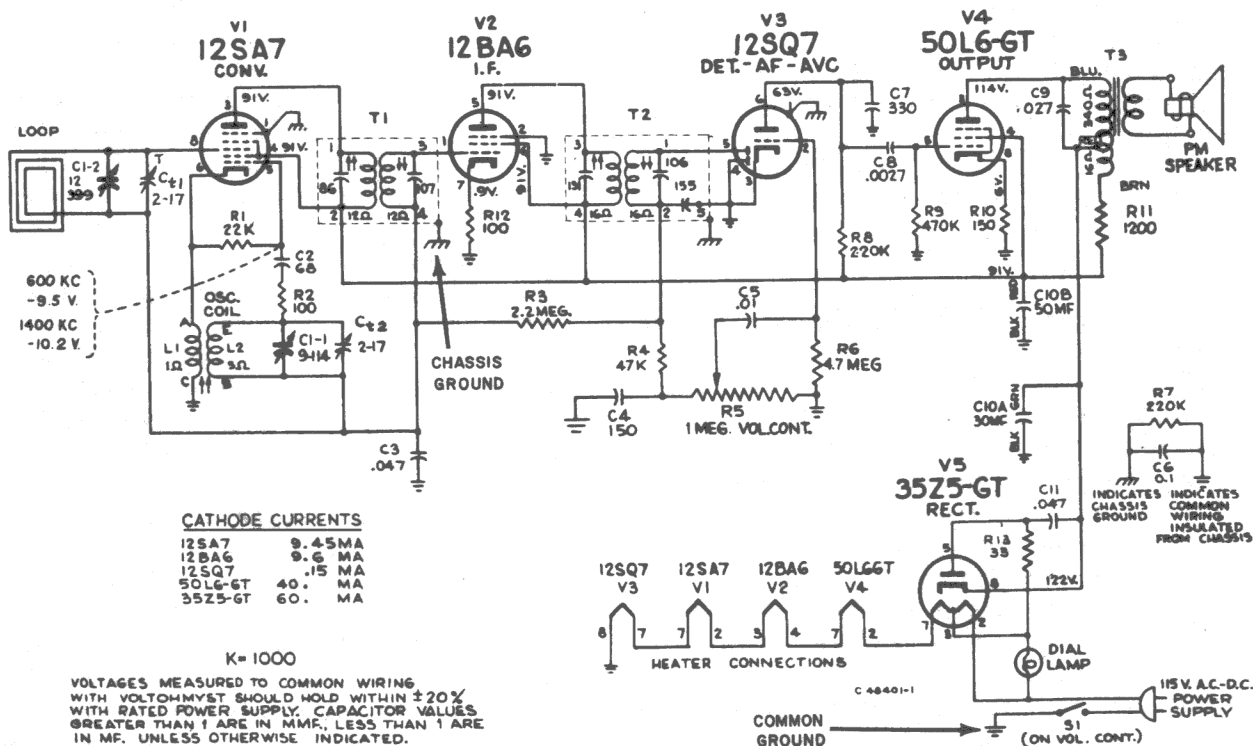
loop antenna (L_1) is probably open. To make sure, connect your ohmmeter leads across the terminals of L_1 . An infinite reading indicates that L_1 is open. Test capacitor C_2 , which is in parallel with L_1 , for a short.

If no click is heard test the 6BA6 tube. If it is good, check the 6BA6 plate voltage, measuring from pin 5 to chassis. The voltage reading should be 215 volts. If a zero voltage reading is obtained, the primary winding of L_2 is open. The primary of L_2 is not shorted to the chassis because, if it were, the 215-volt power supply voltage would be grounded.

If the plate voltage is normal, check the voltage at the screen grid (pin 6). The normal voltage, here, is 100 volts (Fig. 19-2). If a zero reading is obtained, and R_2 is hot, capacitor C_4 is shorted. If R_2 is cold, it is probably opened. Check it with your ohmmeter. If the screen-grid voltage measures 215 volts instead of 100 volts or zero volts, no current is flowing through R_2 and the tube. Check R_1 , the cathode resistor, with your ohmmeter; it may either be opened or have an abnormally high-resistance value.



(a)



(b)

Fig. 19-12

19-2. INOPERATIVE A.C.—D.C. RECEIVER

Our second example—Set *B*—is an inoperative or dead a.c.—d.c. receiver (Fig. 19-12a). The schematic diagram (Fig. 19-12b) shows that the set consists of a converter (12SA7), i-f amplifier (12BA6), detector-AVC-Audio voltage amplifier (12SQ7), audio-power output stage (50L6-GT), and half-wave rectifier power supply (35Z5-GT). The schematic diagram (Fig. 19-12b) will be referred to for troubleshooting Set *B* throughout the remainder of this lesson.

Caution: Be careful when you are handling the chassis of an a.c.—d.c. set. Some a.c.—d.c. sets (not the example being used for Set *B*) have chassis connected directly to the power line.

Checking Tubes in a Dead A.C.—D.C. Set. The heaters of Set *B* and all a.c.—d.c. receivers are connected in series; each heater depends upon the other to complete the circuit. If the heater of one tube opens, none of the tubes will light.

With Set *A*, and all a-c sets, if none of the tubes light, you know that power is not reaching the set. Not so with Set *B*. When none of the tubes light in an a.c.—d.c. set, either power is not reaching the set, or a tube is burned out.

If the set is operated on d.c.—the plug may be reversed in the power outlet. To find out, turn the plug around and then operate the radio. The tubes can be checked in a tube checker, or replaced one-at-a-time; or the open heater can be located with the aid of a meter.

To use the meter method for locating burned-out tubes, the chassis must be removed from its cabinet. Use an a-c meter where a-c power operates the set, a d-c meter where d-c power operates the set. Connect the ground lead from your meter to the common B— wiring (—) of set *B*. Do not connect to chassis. Refer to the heater connection diagram (Fig. 19-12b), and, with the set turned on, touch the meter probe first to pin 2 of V_5 , then pin 3, then pin 7 of V_5 ; then touch pin 2 of V_4 , then pin 7 of V_4 ; and so on—down the line. The meter should indi-

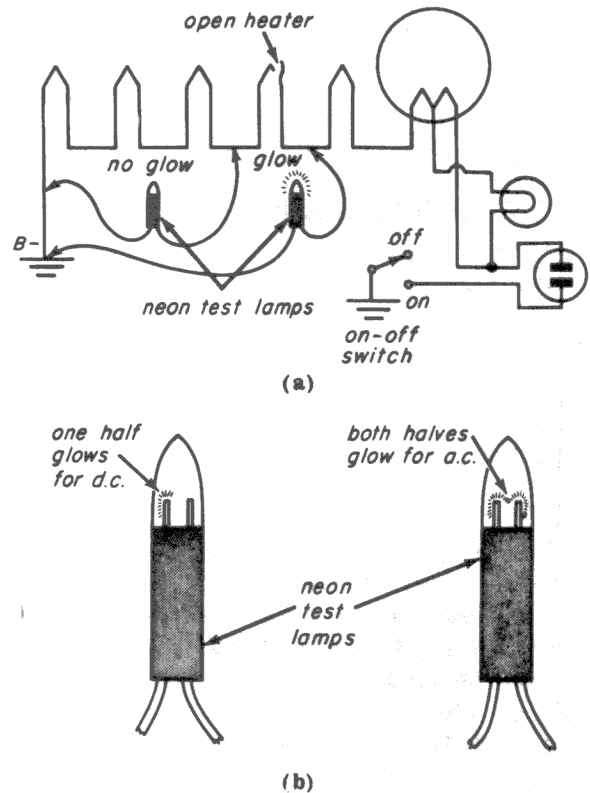


Fig. 19-13

cate 120 volts at pin 2 of V_5 ; the open heater is at the first tube where no voltage is indicated.

A neon test lamp can be used in place of the meter (Fig. 19-13a). Connect one probe of the lamp to B—. Touch the free probe to the heater pins of the tubes in the order shown on the heater connection diagram. When the free probe touches pins on the B+ side of the open heater (as in Fig. 19-13a), the lamp glows. One half of it glows if the power applied to the set is d.c.; both halves glow with a.c. (Fig. 19-13b). When the free probe touches pins located on B— side of the open heater (as in Fig. 19-13a), the lamp does not glow. The tube at which the indication changes from *glow* to *no glow* when the free probe is moved from one heater pin to the other, contains the open heater.

The neon lamp test is intended to be used where no tubes light up. In a set in which all tubes light, the test lamp may not glow when you touch the probe to a heater pin. It glows only when the voltage across its terminal probes is more than 60 volts a.c. or d.c. The voltage between common B— wiring and any heater pin on the high or far side of an open heater is always full line

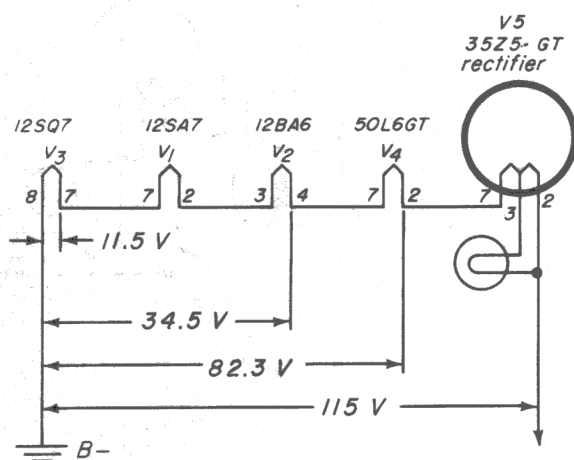


Fig. 19-14

voltage (115 v a.c. or d.c.). However, when all tubes light, the voltage between B- and the various heater pins is not always full line voltage; it is not always over 60 volts. Notice (Fig. 19-14) that the actual voltage across the heaters is less than the rated voltage. This is because the line voltage drops proportionately across the series string.

After you locate a tube with an open heater using the meter or test lamp method you can test it for continuity with an ohmmeter (Fig. 19-15) to make sure that the open is actually inside the tube and not in the chassis wiring. Connect the meter leads between the suspected heater pins of the tube and switch to the $R \times 1$ scale. An infinite reading shows that the heater is open. Normally, tube heaters measure a few ohms resistance.

Tubes can fail in a way that produces a dead set, but still light up. When this happens to tubes in an a.c.-d.c. set they should be tested the same way that tubes in an a-c set are tested—with a tube tester or by substitution.

Checking the Power Supply. An ohmmeter check should be made from pin 8 of the 35Z5 to common ground (B-). A zero-ohm indication shows that capacitor C_{10A} is shorted, and it is not safe to install a new 35Z5 tube. If R_{11} is hot to the touch, the 50- μ f capacitor (C_{10B}) is probably shorted. However, if a d.c. voltage is present between pin 8 of the 35Z5 and common ground, and R_{11} is cold to the touch, and no d.c. voltage is present at

pin 4 of the 50L6, either filter resistor R_{11} or the 16-ohm portion of T_3 is open. These can be checked separately to find out which one is defective.

Checking the Audio and Detector Circuits.

You check for live audio in a.c.-d.c. receivers as you check for live audio in a-c receivers. With Set B, turn on the set; advance the volume control all the way and touch a finger to pin 2, the control grid of the 12SQ7 tube. If a loud hum is heard, the audio section is all right. If no hum is heard the receiver's trouble is in the audio section unless further tests show that it is in the power supply. Make sure that the 12SQ7, 50L6 and 35Z5 tubes either check all right in a tube checker or by substitution.

The 50L6 tube in Set B serves the same purpose as the 6AQ5 tube in Set A. These are audio power-output tubes. With the set turned on, make the screwdriver click test at pin 5 of the 50L6 tube. A click, heard in the speaker, shows that the stage is operating. If no click is heard, proceed, as for the a-c receiver, Set A. Measure plate (pin 3) and screen grid (pin 4) voltages. Measure to common ground, not to chassis ground.

The 12SQ7 tube is the audio voltage amplifier in Set B. It is the same as the 6AV6 tube in Set A. (Unlike Set A, no tone control is used in the 12SQ7 circuit of Set B.) Check the plate voltage of the 12SQ7 from pin 6 to common ground. If R_8 is cold and the plate voltage is zero instead of 63 volts, R_8 is open. If R_8 is warm and the voltage at pin 6 is zero, C_7 is shorted. A

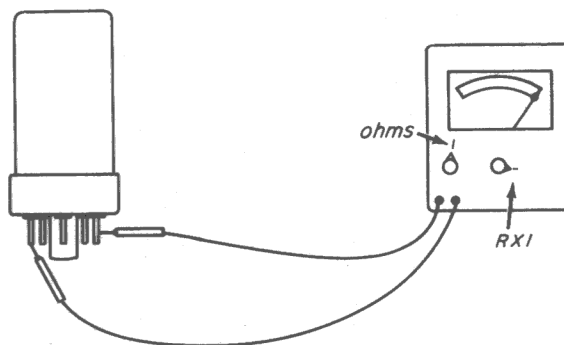


Fig. 19-15

low plate voltage reading may also be due to a shorted coupling capacitor— C_8 . Also check C_8 for an open. Make sure the grid circuit at pin is not grounded.

The screwdriver test, described for the a-c set, is made at pin 5 of the 12SQ7 detector plate in Set B. If no response is obtained, check the detector plate circuit resistance with your ohmmeter connected between pin 5 and common ground. This circuit includes the T_2 secondary winding, R_4 and R_5 —the volume control. Check resistance to ground from the T_2 secondary winding; it may be shorting to chassis—possibly through the 155- μf capacitor connected between terminals 2 and 5 of T_2 . The 106- μf capacitor across the T_2 secondary, or capacitor C_4 may be shorted. Check with your ohmmeter.

Checking the I-F Amplifier and Converter.

The screwdriver click test, made at pin 1 of the 12BA6 i-f amplifier, should produce an audible click. If it does not, the stage is dead; test the 12BA6 tube or substitute it with a new one. Then, check the plate voltage. It should measure 91 volts with respect to common ground. No plate voltage means that the primary of T_2 is open. If the plate voltage is normal measure the cathode voltage. The normal cathode voltage is 0.9 volt. If the voltage measured at the cathode is too high (B+), measure the resistance of R_{12} ; it may be opened, or have too high a resistance. The primary of T_2 is tested in the manner described for similar transformers. Make sure that the capacitor connected between terminals 3 and 4 is not shorted.

Make a screwdriver click test at pin 8 of the 12SA7 converter tube. If no click is heard, the stage is dead. Test the 12SA7 tube. Then check the plate voltage at pin 3. The normal value is 91 volts. Zero voltage indicates that the primary of T_1 is open. Test the loop antenna, tuning capacitor, and trimmer capacitor (Fig. 19-12b).

Checking the Oscillator. There is no r-f stage in Set B. The antenna is connected directly to the converter grid (pin 8). If the converter and all other stages check good, the trouble must be in the oscillator.

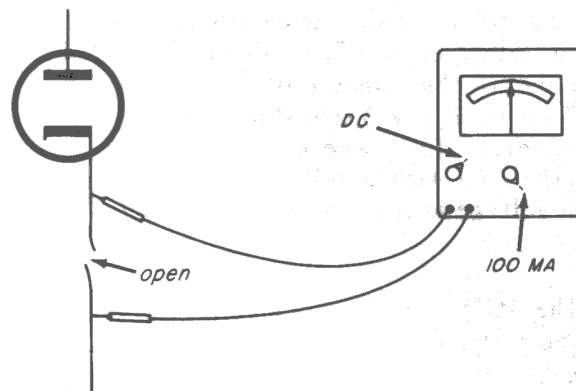


Fig. 19-16

Connect one voltmeter lead through a 100 k-ohm resistor to pin 5 of the 12SA7 and the other to common ground and measure the negative d.c. voltage. If the voltage reading is zero the oscillator is not oscillating. Make a resistance check from pin 6, the cathode of the 12SA7, to common ground; an infinite reading indicates that the primary of L_1 is open. Take a resistance reading between pin 5 of the oscillator grid and common ground; an infinite reading shows that R_1 , the oscillator grid leak resistor, is open. Place the ohmmeter leads across terminals E and B of the oscillator-coil secondary winding; an infinite reading shows that the secondary is open; a five ohm indication is normal. However, if the ohmmeter reads zero ohms ($R \times 1$ scale), either C_{1-1} , the tuning capacitor, or C_{12} , the trimmer capacitor is shorted. These should be separately checked to see which one is at fault. Check resistor R_2 to see if it is open. Then, check capacitor C_2 to see if it is shorted. If not, temporarily remove it from the circuit and try a substitute 68- μf capacitor in its place.

Checking Cathode Current. The normal cathode current for each tube in Set B is shown in a table, included in the schematic diagram (Fig. 19-12b). To measure the cathode current of a tube, open (unsolder) the cathode lead and place your meter in series with the tube (Fig. 19-16). Then, switch the meter selector switch to DC, and the range switch to the required ampere positions.

Cathode-current readings provide much the same troubleshooting information as that provided by plate and screen grid voltage readings. Take the 60-ma cathode current of the

35Z5 rectifier. This current supplies all the other tubes in Set B; it flows through R_{11} and the 16-ohm winding of T_3 . If either R_{11} or T_3 is open, the 35Z5 60-ma cathode current disappears. The same defects (open R_{11} or T_3) show up with a voltage check indicating zero voltage at pin 4 of the 50L6-GT tube.

The 35Z5 60-ma cathode current is the sum of the cathode currents of all the other tubes. The 50L6-GT draws 40 ma. If it is not conducting (A tube can light up but fail to conduct.), the cathode current of the 35Z5 becomes 20 ma. When your meter shows 20 ma instead of 60 ma in the cathode of the 35Z5, immediately, you suspect the 50L6. You check the cathode current of the 50L6. If it is zero, you try a new 50L6 tube. Then, if it is still zero, you check the cathode resistor (R_{10}) for an open, etc.

Misalignment. Alignment is the name given to the process of adjusting r-f, i-f, and oscillator circuits to their proper resonant frequency. If these adjustments are set far off their proper setting (*misalignment*), the receiver does not operate. It is a dead set. *All voltages and resistances are correct.* The audio and power supply circuits work properly. The oscillator oscillates. But, the i-f and converter circuits do not work.

For misalignment to be severe enough to result in a dead-set, the alignment adjustments must be set in the wrong position. This cannot be the case with a set that worked properly at one time—unless someone tampered with the adjustments. The adjustment settings can change, slightly, of their own accord, but not enough to cause a dead set. A detailed alignment procedure will be given in later lessons.
